

A REVISION OF THE NORTH AMERICAN SPECIES  
OF THE GENUS PLAGODIS (LEPIDOPTERA,  
GEOMETRIDÆ, ENNOMINÆ)

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The confusion that has existed for many years in connection with the North American species of the genus *Plagodis* Hübner has been due, in part, to lack of understanding of the relationship among the various seasonal forms and geographical races, but it has been further complicated by an unusual nomenclatorial mix-up which was begun by Grote and Packard in 1876, and which has never been satisfactorily cleared up. The purpose of this article is not to present an exhaustive discussion of the genus, but rather to clarify the use of certain specific and subspecific names, to correct a few prevalent misunderstandings, and to present a few hitherto unpublished facts.

The nomenclatorial mix-up already mentioned is concerned with the names *kuetzingi* Grote, *keutzingaria* Packard, *nigrescaria* Hulst, *purpuraria* Pearsall, and *altruaria* Pearsall. To promote a clearer understanding of the application of these names as used later in this article, a brief account of their history will be given, followed by what seems to be the most logical interpretation of their correct usage.

When Packard was preparing material for his monograph he had for observation a series composed of three species, but which he regarded as only one. For this supposed species he had evidently chosen the name *purpuraria*. At least, certain specimens, notably two in the Field Museum in Chicago, still exist so labeled in his handwriting. In the meantime Grote had acquired a single specimen of the darkest of these species, and had sent to the Canadian Entomologist a note stating that the type and a description of this *purple-black* species had been sent to Packard, who would include in the Monograph a description of it under the name *Eurymene kuetzingi*. This note was published in the June 1876 issue, almost simultaneously with the appearance of Packard's monograph.

Packard, after receiving this material from Grote, evidently revised his manuscript slightly, changing the name from *purpuraria* to *keutzingaria*, which he regarded as a corrected and more appropriate form of the Grote name. He also added a sentence of description applicable to Grote's specimen, and figured this form on the supplementary plate.

In 1887, Hulst, realizing that the dark purple species was distinct from the paler ones, proposed the name *nigrescaria* for it (Ent. Amer. II, p. 212), evidently assuming that Grote had not described the species, and that the paler ones were the true *keutzingaria*.

In 1907, Pearsall decided that the current application of the names was incorrect (Ent. News, XVIII, p. 206). He assumed that Grote's note in the Canadian Entomologist constituted an adequate description, and that it preceded Packard's Monograph. Thus his solution was to validate *kuetzingi* Grote for the dark species, with *nigrescaria* Hulst as a synonym. He then proposed the name *altruaria* for what he called "the other species," since he felt that *keutzingaria* and *kuetzingi* could not be retained in the same genus. On the next page Pearsall described *purpuraria*. He had seen not only the two specimens which are now in the Field Museum, but also one additional specimen. He recognized these as representing a distinct species, but misinterpreted the significance of the Packard labels, evidently believing that Packard had chosen the name for this as a distinct species, but had not actually published the description.

By 1917, when the Barnes and McDunnough Contributions appeared, the name *keutzingaria* was being applied to the common light colored spring form that occurs in the northeastern states, and they selected a specimen of this form from Packard's original series to be called the type of *keutzingaria*.

The following interpretation of this complicated situation seems reasonable, logical, and not likely to add to the confusion. Since Grote's note in the Canadian Entomologist designates the name *kuetzingi* to apply to a purple-black species, and since that note includes the first published reference to that name, it constitutes a description, regardless of whether Grote intended

it as such or not. Furthermore this description was accompanied by a type which is still in existence in the British Museum, and still bears Grote's original type label. Mr. Tams has been kind enough to furnish a photograph of it and of the label. There is no doubt as to the species involved.

The Packard name *keutzingaria* is actually a distinct name, even though it was evidently intended to be merely a revision of the Grote name. Although Packard's concept of *keutzingaria* included Grote's *kuetzingi*, his description, in general, indicates one of the paler forms, and is reasonably harmonious with the lectotype chosen by Barnes and McDunnough. I have examined this specimen, which is now in the Museum of Comparative Zoology at Cambridge.

Pearsall's description of *purpuraria* provides us with a suitable name for the third species.

Thus the names will be applied in this article—*kuetzingi* Grote to the purple-black species, *keutzingaria* Packard to the paler form common in the northeastern states, and now known to be only the spring form of *phlogosaria* Guenée, and *purpuraria* Pearsall to the species with intermediate coloring and more southern range.

#### Genus PLAGODIS Hübner

*Plagodis* Hübner, Verz. bek. Schmett., 294. 1823.

Type: *P. Geometra dolabraria* Linnaeus (Monobasic).

*Ennomos* Treitschke (pars), Schmett. Eur., V (2), 427. 1825.

*Eurymene* Duponchel, in Godart, Hist. Nat. Lepid. France VII (2), 105, 185, 1829.

Type: *P. Geometra dolabraria* Linnaeus (Original description and monobasic).

(Genus proposed and type designated 105, described 185.)

*Ennomos* Treitschke, Boisduval (pars), Gen. et Ind. Meth. Eur. Lepid., 182. 1840.

An examination of all the North American material available seems to indicate the presence of only six distinct species, all strictly congeneric with the Eurasian *dolabraria* Linnaeus. For purposes of comparison, *dolabraria* is figured on Plate V, Fig. 1,

the male genitalia on Plate I, Fig. 1, and the female genitalia on Plate III, Fig. 5. It might also be noted that the larva as figured by Spuler (Die Schmetterlinge Europas, IV, Die Raupen, Plate 41, Fig. 15, 1910) appears almost identical with all known American larvæ of the genus. I can find no record, however, that moths of the summer generation, as they occur in southern Europe, differ in any obvious way from those of the spring generation. Although the species ranges from Portugal and Great Britain to Japan, racial differences are far less pronounced than in the one American species that ranges across the continent.

PLAGODIS SERINARIA Herrich-Schäffer

Plate V, Fig. 2; Plate I, Fig. 2 (male genitalia); Plate III, Fig. 3 (female genitalia); Plate II, Fig. 5 (larva).

*Plagodis serinaria* Herrich-Schäffer, Ausser. Schmett., 63; Fig. 365. 1855.

*Ellopiia subprivata* Walker, Cat. Brit. Museum, XXVI, 1509. 1862.

*Eurymene rosaria* Grote, Bull. Buff. Soc., III, 131. 1876.

*Eurymene rosaria* Grote, Can. Ent., VIII, 111. 1876.

*Plagodis serinaria* H.-S. Packard, Mon. of Geom. Moths, 469; Plate XI. Fig. 45. 1876.

*Plagodis floscularia* Grote, Pap. I, 40. 1881.

*Plagodis serinaria* H.-S., Holland, Moth Book, 349; Plate XLIV, Fig. 33, ♂. 1903.

*Serinaria*, with its beautiful blending of yellow and rose, is not easily confused with other species, and is too well known to need further description. It varies considerably in the amount and the brilliance of the rose, and, as in some other species of the genus, the discal spot may be either present or absent.

MALE GENITALIA.—Examination of the male genitalia of the various species of *Plagodis* reveals significant differences only in the shape of the valves; in the number, size, and arrangement of the cornuti; and in the symmetry and spining of the furca. Other features, which seem quite constant throughout the genus, are shown in the figures, and will not be otherwise



specifically considered. In *serinaria* the outer portions of the valves are somewhat narrowed, and the cornuti, which usually number from six to nine, are arranged side by side in a single group. In all specimens examined the furca is asymmetrical, both branches tipped with a few spines, more loosely arranged on the long right branch than on the shorter left one. The relative length of the branches of the furca, however, is not too constant in some species of this group, and may be found to vary in this species also.

FEMALE GENITALIA.—As a basis for specific determination, the female genitalia seem more reliable throughout the genus than the male genitalia. They show, on the whole, greater differences among the species, but seem relatively constant within the species. In *serinaria* the most distinctive feature is the long, slender, plaited ductus bursae, moderately chitinized, and separated from the bursa proper by a distinct line of division. The signum is comparatively large for the genus, and there is no chitinized bar above the ostium, such as is found in some of the species.

EARLY STAGES.—The eggs are smooth, pale yellow, ellipsoidal, somewhat flattened, and deposited in irregular clusters upon the leaves. Within a few days they develop a few pinkish flecks, but not the uniform red coloring found in the eggs of many of the *Ennominae*.

The newly hatched larvæ are pale yellowish green, smooth, with no obvious markings. During the next two instars they remain rather nondescript green larvæ not easily distinguished from those of various other species. In the fourth instar a hump develops on the fifth abdominal segment, and some brown and purplish mottling. In the final instar the larvæ are brownish, irregularly marked with fine darker flecks and larger pale areas, and with an oblique dark lateral stripe on each side of the first abdominal segment. These stripes do not quite meet dorsally to form a V and each is bordered with an indistinct paler stripe immediately back of it. The second abdominal segment has traces of these stripes also. Underneath on each of the first five abdominal segments there are two small but distinct black tubercles, each tipped with a single spine. The

fifth abdominal segment has a conspicuous dorsal hump, and the eighth abdominal segment a pair of moderately well developed subdorsal warts. These larvæ do not seem to have the habit of withdrawing the head into the thorax when at rest, but keep it well extended at all times. They feed freely upon basswood (*Tilia americana*), and probably upon other trees and shrubs. In western New York the larvæ are full grown in late July and early August.

The pupa is dark brown, with wing cases almost black, and only moderately glossy. The cremaster is of the eight-hooked type, with the two apical hooks longer and stouter than the other six, and all hooks with recurved tips. The dorsal and lateral grooves of the adjacent abdominal segments, that in most genera accompany the eight-hooked cremaster, are missing, or are indicated only by vestigial lateral grooves. This combination of characters at the tip of the abdomen is unusual, but has been observed in the related genus *Hyperetis*, and probably occurs in *Anagoga*.

In general *serinaria* is the closest of any American species to *dolabraria*, agreeing with it in size, wing form, male genitalia, and in most features of the female genitalia. The species ranges from Nova Scotia westward at least to Manitoba, and south to the latitude of southern Ohio. The types are from the vicinity of Cincinnati. In New York the moths fly in May and June, and there is but one generation a year.

Number of specimens examined: 109 ♂♂, 25 ♀♀. (The numbers recorded for this and each succeeding species do not include the specimens in the Museum of Comparative Zoology at Cambridge, which were seen, but, unfortunately, not counted.)

#### PLAGODIS KUETZINGI (Grote)

Plate V, Fig. 3; Plate I, Fig. 3 (male genitalia); Plate III, Fig. 4 (female genitalia).

*Eurymene kuetzingi* Grote, Can. Ent., VIII, 112. 1876.

*Plagodis keutzingaria* Packard (pars), Mon. of Geom. Moths, 468; Plate XIII, Fig. 51. 1876.

*Plagodis nigrescens* Hulst, Ent. Amer., II, 212. 1887.

*Plagodis kuetzingi* (sic) Pearsall, Ent. News, XVIII, 206. 1907.

*Plagodis keutzingi* (sic) Holland, Moth Book, 349; Plate XLIV, Fig. 36, ♂. 1903.

*Plagodis nigrescaria* Hulst. B. and McD., Cont. to the Nat. Hist. of the Lepid. of N. A., III, 249. 1917.

*Kuetzingi* is recognized at once by the large area of purplish black covering the outer half of the upper wings except along the costa. The postmedial line curves far inward, and forms, in an indistinct sort of way, the inner boundary of this dark area. The antemedial line is indicated only as the outer boundary of a light brown or buff basal area. The lower wings also show a considerable suffusion of purple black scales over the wide terminal area.

• MALE GENITALIA.—The male genitalia agree with those of *serinaria* in the narrowed extremities of the valves, but differ from those of all other species in the presence of a well defined notch in the costa of the valve at its base. The furca is quite symmetrical in all specimens examined, with both branches short, and equipped with unusually long spines at the tips. The cornuti are arranged in two groups, usually of two each, those of one group somewhat shorter than those of the other.

FEMALE GENITALIA.—The ductus bursæ, which is less heavily chitinized and less distinctly plaited than in *dolabraria* and *serinaria*, is short, and merges gradually into the bursa proper. A more or less curved, heavily chitinized bar is present above the ostium.

EARLY STAGES.—These were first worked out in the summer of 1946 by Mr. Douglas C. Ferguson of Armdale, Nova Scotia. When, in July of that year, I saw the larvæ he was rearing, they were still quite small, but looked about like those of other species of the genus. They were feeding upon ash, which seemed to be, of all the foods offered, the only one they would accept. Later Mr. Ferguson sent me preserved larvæ for study. In the fourth instar they are still uniform pale green, with a slight hump on the fifth abdominal segment. In the fifth and final instar they resemble the larvæ of *serinaria*, but are considerably paler, with the head contrasting dark brown. The oblique lateral lines are missing, and there is not much of the darker mottling on the first four abdominal segments, although

the remaining segments show traces of it. The paired ventral tubercles are present on only the first three abdominal segments. These larvæ, when at rest, withdraw the head into the thoracic segments, but apparently not so completely as do the larvæ of *phlogosaria* and *alcoolaria*. The pupa is structurally similar to that of *serinaria*.

*Kuetzingi* is one of the most clearly defined species of the genus, differing from all other purplish species in its much darker color, its very narrow median area, and in the more shallow excavation at the anal angle of the upper wing. It has a wide range from Nova Scotia through New England, New York, and Ontario, at least as far west as northern Illinois, but seems local in distribution, and is rare or absent south of the latitude of the Great Lakes. In western New York the moth flies from late May well into June. A single late July record from Illinois may represent a second generation, or, more probably, an accidentally belated individual.

Number of specimens examined: 62 ♂♂, 5 ♀♀.

#### PLAGODIS PURPURARIA Pearsall

Plate V, Fig. 4; Plate I, Fig. 4 (male genitalia); Plate III, Fig. 6 (female genitalia).

*Plagodis keutzingaria* Packard (pars), Mon. of Geom. Moths, 468; Plate XI, Fig. 44, 1876.

*Plagodis purpuraria* Pearsall, Ent. News, XVIII, 207. 1907.

Although *purpuraria* reminds one of *kuetzingi*, it is much paler, and the postmedial line is less incurved. The purple scales are very smoothly distributed over the terminal areas of all four wings, but are denser near the anal angle of each wing, becoming gradually lighter near the costa, without the spotty effect found in *phlogosaria* and its forms. There is a considerable washing of orange in the median area and underneath, but few or no transverse striæ, and no discal spot in any specimen examined. The antemedial line, if visible at all, is very faint.

MALE GENITALIA.—The valves are not much narrowed apically. The furca is symmetrical, with both branches short, not extending to the costal margin of the valves, and each branch is tipped with a few long spines. There are two well separated groups of cornuti, usually two in each group.

FEMALE GENITALIA.—The ductus bursæ is short, only slightly chitinized, and scarcely plaited. The chitinized bar above the ostium is about as wide as in *kuetzingi*, but is of more nearly uniform width, and the membrane back of it appears to have a very ragged edge.

*Purpuraria* seems, in general, to be a rather scarce species, but it has been taken in numbers near Finleyville, Penna. The type is from Scranton, and other specimens have been seen from Delaware, Maryland, southeastern New York, and northern Illinois. I can discover no record of the early stages.

Number of specimens examined: 78 ♂♂, 4 ♀♀.

PLAGODIS PURPURARIA summer form SCHUYLKILL-  
ENSIS Grossbeck

Plate V, Fig. 5.

*Plagodis schuykillensis* Grossbeck, Ent. News, XIX, 315. 1908.

In the same limited area where *purpuraria* occurs in the spring, a very different looking form flies in July and August. Since the differences between these forms correspond exactly to known differences between the seasonal forms of *phlogosaria*, there can be no doubt that *schuykillensis* is merely the summer form of *purpuraria*.

This form closely resembles typical *phlogosaria*, but differs chiefly in having the postmedial line nearer the middle of the wing, and in having the dark scales spread evenly over the upper wings, and the terminal areas of the lower wings. There is no discal spot in any specimen seen, and scarcely any indication of the green sheen so often found in *phlogosaria*.

In the male genitalia a remarkable situation has developed, similar to that found in *phlogosaria* and *fervidaria*. The furca in the summer form is asymmetrical, with the right branch fully twice as long as in the spring form, and the left branch somewhat longer than in the spring form. The genus *Plagodis*, so far as I know, is unique among the *Geometridæ* in having species that show constant seasonal differences in male genitalia. Such differences do not occur in the female genitalia.

The types of *schuykillensis* are from Philadelphia, and all the specimens I have seen are from West Virginia, Pennsyl-



vania, and southeastern New York. Most of the known specimens of this form, as well as of typical *purpuraria*, are from Finleyville, Penna., and are in the Carnegie Museum collection.

Number of specimens examined: 61 ♂♂, 7 ♀♀.

PLAGODIS PHLOGOSARIA (Guenée)

Plate V, Fig. 6; Plate I, Fig. 5 (male genitalia); Plate IV, Fig. 1 (female genitalia).

*Eurymene phlogosaria* Guenée, *Lép. Noct.* IX, 146. 1857.

*Eurymene phlogosaria* Gn., Walker, *Cat. Br. Museum*, XX, 177. 1860.

*Plagodis phlogosaria* (Gn.) Packard, *Mon. of Geom. Moths*, 466; Plate XI, Fig. 42. 1876.

*Plagodis phlogosaria* (Gn.) Bruce, *Ent. Amer.*, III, 48. 1887. (Early stages.)

*Plagodis phlogosaria* (Gn.) B. and McD., *Cont. to the Nat. Hist. of the Lepid. of N. A.*, III, 248; Plate XXII, Fig. 3, ♂. 1917.

*Eurymene phlogosaria* Gn., Oberthür. *Etudes de Lép. Comp.*, Fasc. VI; Plate CLVIII, Fig. 1532. 1920.

In the typical form the ground color is bright yellowish brown, dusted with darker scales, and usually showing a trace of transverse striæ of brown and purple near the costa of the upper wings. The postmedial line of the upper wings is narrow, distinct, and nearly straight, almost always continuous, and usually bordered inwardly by an indistinct, narrow purplish shade. In the terminal area there may be some scattered purple scales, and there is always a smudge of purple and brown near the anal angle. The median area is more uniform in color, may show a strong green tinge, and usually a discal spot. The dark brown antemedial line is almost always well defined, narrow, and widening near the costa. The lower wings are lighter, clearer yellow, overlaid with brown, black, and a few purple scales in the terminal area, especially near the anal angle, where they tend to form lines parallel to the postmedial line. On the underside the pattern is somewhat similar, but the flecks and lines are rosy purple on a bright yellow background. The two sexes are similar in color, but the anal ex-

cavation, which is deeper than in any of the species previously considered, is more strongly developed in the females than in the males.

**MALE GENITALIA.**—The male genitalia are scarcely distinguishable from those of *schuykillensis*, showing a similar asymmetrical furca and two groups of cornuti. There are usually two cornuti in each group, but occasionally the division is 1-3, 1-2, or 2-3.

**FEMALE GENITALIA.**—In general these are similar to those of *purpuraria*, but a few significant differences seem constant. The ductus bursæ is a little wider; the signum is larger and carries more points; the chitinized bar near the ostium is narrower, less strongly curved centrally, but with the ends turning abruptly downward; and the ragged membrane behind this bar is less conspicuous and less ragged than in *purpuraria*.

**EARLY STAGES.**—The eggs undergo greater color change than those of *serinaria*, becoming bright red a few days after being laid. The larvæ in all stages resemble those of *serinaria*, except in the matter of the retractile head in the last instar. Resting larvæ of *phlogosaria* usually withdraw their heads almost completely out of sight, and fold their legs close against the thorax. This performance gives them the appearance of small gnarled twigs, each ending in a smooth rounded knob. The first two abdominal segments often show a trace of pale longitudinal lateral lines, not oblique as in *serinaria*. The paired ventral tubercles are present on each of the first five abdominal segments, but they are smaller than in *serinaria*. Evidently the larvæ will feed upon various trees and shrubs, but I found wild cherry (*Prunus serotina*) and white birch (*Betula alba*) the most satisfactory of anything tried. Dr. McDunnough reported rearing the northern race *intermediaria* on basswood (Can. Ent., June 1933, p. 124).

Structurally the pupa is similar to that of *serinaria*, but the general appearance is quite different, for it is lighter brown, with greenish wing cases, and rather glossy.

Typical *phlogosaria* is the regular summer form in the New England States, New York, and southern Ontario, ranging westward at least to Minnesota, and southward to southern Penn-

sylvania and Ohio. It flies in July and early August, and in some localities is quite abundant.

Number of specimens examined: 164 ♂♂, 28 ♀♀.

PLAGODIS PHLOGOSARIA spring form KEUTZINGARIA  
Packard

Plate V, Fig. 7; Plate I, Fig. 6 (male genitalia); Plate IV, Fig. 2 (female genitalia).

*Plagodis keutzingaria* Packard (pars), Mon. of Geom. Moths, 468. 1876.

*Plagodis altruararia* Pearsall, Ent. News, XVIII, 206. 1907.

*Plagodis kuetzingaria* (sic) B. and McD., Cont. to the Nat. Hist. of the Lepid. of N. A., III, 249; IV, 155; Plate XXIII, Fig. 3. 1917.

Except in the basal area of the upper wings the ground color of the spring form is less tawny than in typical *phlogosaria*, and is usually more heavily striated with purple and brown scales. The postmedial line is broad, dark brown, and inwardly bordered with a much wider and more diffused purple shade than in the typical form, and is usually nearer the middle of the wing. The antemedial line, which is usually not quite so heavy, is similar in color, but outwardly diffused. There is a tendency for the discal spot to be lost, and the greenish sheen of the median area, while often present, may be obscured by the darker striæ. The dark smudge at the anal angle is also more diffused than in typical *phlogosaria*. The lower wings are straw yellow, with some purple scales in the terminal area. The pattern of the under side is similar to that of the typical form, but more liberally flecked with rosy purple, which may cover the terminal area almost uniformly. Occasional specimens of both the spring and summer forms are intermediate in coloring, similar to the northern race *intermediaria* B. and McD.

The male genitalia, as in *purpuraria*, have a symmetrical furca, with both branches quite short, and tipped with shorter spines than in typical *phlogosaria*. The female genitalia are indistinguishable from those of the typical form.

*Keutzingaria* flies earlier in the spring than any other northern *Plagodis*, sometimes appearing in western New York in

early April, continuing on the wing until the middle of May. Until recently it had been regarded as a species very distinct from *phlogosaria*, and it was something of a surprise when, in 1945, I obtained the typical form in the summer from eggs laid by a female of *keutzingaria* in April.

Number of specimens examined: 106 ♂♂, 8 ♀♀.

PLAGODIS PHLOGOSARIA race INTERMEDIARIA  
Barnes and McDunnough

Plate V, Fig. 8.

*Plagodis intermediaria* Barnes and McDunnough, Cont. to the Nat. Hist. of the Lepid. of N. A., III, 248; Plate XXII, Fig. 2, ♂. 1917.

*Plagodis intermediaria* B. and McD., McDunnough, Can. Ent., LXV, 124. 1933. (Early stages.)

In Ontario and Quebec, north of the area where typical *phlogosaria* and *keutzingaria* occur, is found an apparently single-brooded race, flying in May and June, and intermediate in appearance between the seasonal forms found farther south. On the whole it tends more to resemble *keutzingaria*, but the post-medial line is narrower and clearer, the transverse striæ are less noticeable, and the discal spot is usually present. The genitalia are similar to those of *keutzingaria*.

Dr. McDunnough's account of the early stages seems to indicate a larva and pupa identical in appearance with the *phlogosaria* larvæ I have reared in western New York. His statement that the hump is on the seventh abdominal segment is probably a purely accidental slip.

Number of specimens examined: 2 ♂♂, 1 ♀.

PLAGODIS PHLOGOSARIA race IRIS new race

Plate V, Fig. 9.

*Plagodis approximaria* B. and McD. (pars), Cont. to the Nat. Hist. of the Lepid. of N. A., III, 248; Plate XXII, Fig. 1, ♂. 1917. (nec. *approximaria* Dyar)

In Nova Scotia another single-brooded strain occurs, differing sufficiently from any other to warrant separation as a distinct race. Its most striking feature is the brilliant and intense coloring, particularly on the lower wings and under side. The upper wings are like those of a dark and richly colored

*keutzingaria*, with bronze undertones and the usual green sheen, but with relatively few transverse striæ. The postmedial line is sharply defined, almost black, and usually set farther from the outer margin than in any other *phlogosaria* form except *approximaria*. The discal spot is usually absent or very obscure. The lower wings have a wide terminal area of purple pink, and frequently the entire lower wings are heavily overlaid with scales of the same color. Underneath the rosy purple suffusion is more complete than in *keutzingaria*, and may almost cover all four wings. The postmedial line on the under side of the lower wings is not usually well defined, as in *keutzingaria*, but the terminal area is very wide and intensely purple. The moths average a bit larger than *keutzingaria*, but about the same size as *approximaria*. The wing form is like that of *keutzingaria*, however, with a deeper anal excavation than in *approximaria*. The male genitalia are like those of *keutzingaria*.

Unfortunately the accompanying photograph (Plate 5) was taken before I had seen an extensive series of Nova Scotia specimens, and the one figured is scarcely typical of the race. It is too pale, and shows a more distinct discal spot than is usual. A few other Nova Scotia specimens seen are even less brilliant, and could easily be referred to *keutzingaria*, or possibly to *intermediaria*.

HOLOTYPE.—♂, Armdale, N. S., June 13, 1947 (D. C. Ferguson). In U. S. N. M. collection (ex Ferguson coll.).

ALLOTYPE.—♀, Armdale, N. S., June 24, 1944 (D. C. Ferguson). In U. S. N. M. collection (ex Ferguson coll.).

PARATYPES.—8 ♂♂, 1 ♀, Armdale, N. S.; 3 ♂♂, Annapolis Royal, N. S.; 4 ♀♀, MacNab's Island, N. S. Dates range from early June to early July. The Armdale and Annapolis Royal specimens were collected by Mr. Ferguson, and are in the Ferguson and Rupert collections. The specimens collected on MacNab's Island, in Halifax Harbour, are in the collection of the Nova Scotia Museum of Science in Halifax.

PLAGODIS PHLOGOSARIA race APPROXIMARIA Dyar  
Plate V, Fig. 10 (spring form), Fig. 11 (summer form); Plate  
II, Fig. 1 (male genitalia, summer form); Plate IV, Fig. 4  
(female genitalia).

*Plagodis approximaria* Dyar, Can. Ent., XXXI, 266. 1899.

*Plagodis approximaria* B. and McD. (pars), Cont. to the Nat.  
Hist. of the Lepid. of N. A., III, 248. 1917.

From the eastern spring form *keutzingaria*, the spring form of the western race differs most conspicuously in the form and



position of the postmedial line, which is often almost as completely incurved as in *purpuraria*. In general *approximaria* is slightly larger than *keutzingaria*, a little ruddier, with fewer transverse striæ, and a shallower anal excavation of the upper wings. Neither the male nor the female genitalia show, in the spring form, any significant differences from those of the eastern spring form. All specimens seen from Saskatchewan, Idaho, Washington, Oregon, and British Columbia seem to be referable to this race.

The summer form of *approximaria* differs somewhat less in appearance from its spring form than does its counterpart, typical *phlogosaria* in the east. The two specimens before me scarcely differ in general color from the spring form. The postmedial line of the upper wings, while complete and obvious, is not contrastingly dark, as in most forms of the species, but diffused and grayish, and is much less incurved than in the spring form. There are no obvious transverse striæ, but a small discal dot is present. As in the spring form, the anal excavation is rather shallow. On the lower wings the postmedial line is darker, very distinct near the inner margin, and narrower than that of the upper wings.

The male genitalia, in the only specimen examined, have both branches of the furca longer than those of the spring form, but without the much elongated right branch that is characteristic of the eastern summer forms of this and the two related species.

Number of specimens examined: 13 ♂♂, 1 ♀, also 2 ♂♂ of the summer form, taken at Warrendale, Multnomah Co., Oregon, July 8, 1934, and now in the Franclemont collection.

#### PLAGODIS FERVIDARIA (Herrich-Schäffer)

Plate V, Fig. 12; Plate II, Fig. 2 (male genitalia); Plate IV, Fig. 5 (female genitalia).

*Eurymene fervidaria* Herrich-Schäffer, Ausser, Schmett., Fig. 203. 1850-58.

*Eurymene emargataria* Guenée, Lep. Noct., IX, 145. 1857.

*Eurymene fervidaria* H.-S., Walker, Cat. of the Brit. Museum, XX, 177. 1860.

*Eurymene excavaria* Morrison, Bull. Buff. Soc., I, 189. 1873.

*Plagodis fervidaria* (H.-S.) Packard, Mon. of Geom. Moths, 467; Plate XI, Fig. 43. 1876.

*Eurymene fervidaria* H.-S., Hulst, Ent. News, VI, 104. 1895.

*Fervidaria* is very closely related to *phlogosaria*. The typical spring form can be separated from *keutzingaria* by the deeper excavation at the anal angle of the upper wing, by the blurred and usually incomplete postmedial and antemedial lines, and by the greater number of transverse darker striæ. These frequently cover the upper wings so completely that the other markings are almost lost among them. As a rule the postmedial line of the upper wing is heavier near the inner margin, wide and diffused, gradually disappearing toward the costal margin. The antemedial line, however, is heavier near the costa, often indicated only as a dark blur at that edge of the wing. Occasionally the complete line is present but faint, and sometimes no trace of it can be found. There is rarely any sign of a discal dot. The lower wings are similar to those of *keutzingaria*, but brighter, purer yellow, and less suffused with purple. The under side is more heavily flecked with purple scales than in *keutzingaria*, and the ground color, which shows most clearly in the basal area of the lower wings and near the apex of the upper wings, is more intense golden yellow.

The male genitalia are almost like those of *keutzingaria*, except in the number of cornuti. In *fervidaria* the usual number in the larger group is from five to seven, with four the minimum number observed, and that in just one specimen. The female genitalia differ from those of *phlogosaria* chiefly in the smaller bursa, and the greater curvature of the bar above the ostium.

So far as I know, the early stages of this species have not been studied. It is more southern in its range than any of the species previously considered, occurring from the southern parts of New York and the New England States to southern Alabama and Georgia.

Number of specimens examined: 35 ♂♂, 3 ♀♀.

PLAGODIS FERVIDARIA summer form ARROGARIA  
(Hulst)

Plate V, Fig. 13, ♂; Fig. 14, ♀; Plate II, Fig. 3 (male genitalia); Plate III, Fig. 7 (female genitalia).

*Eurymene arrogaria* Hulst, Ent. Amer., I, 208. 1886.

*Plagodis arrogaria* (Hlst.) B. and McD., Cont. to the Nat. Hist. of the Lepid. of N. A., III, 186; Plate XIV, Fig. 12, ♂. 1917.

*Arrogaria* has stood as a recognized species in all lists for many years, but since it bears in all known respects the same relation to typical *fervidaria* that typical *phlogosaria* bears to *keutzingaria*, I do not hesitate to treat it merely as a seasonal form of *fervidaria*.

It is slightly smaller than typical *fervidaria*, brighter yellow in ground color, especially on the lower wings, and with few transverse striae. The postmedial line is narrow, usually distinct for only a short distance at the inner margin of each wing. In most specimens the remainder of the line is very obscure or entirely missing. The antemedial line is also obscure, often indicated by only a small spot on the costal margin. Every specimen observed has a conspicuous discal dot on the upper wing. Underneath the colors are even more brilliant than in the typical form, and with fewer dark flecks.

The male genitalia show a furca as asymmetrical as that of *phlogosaria*, but the other features are like those of typical *fervidaria*. The female genitalia cannot be distinguished from those of the typical form. *Arrogaria* seems to occur throughout the geographical range of the species.

Number of specimens examined: 20 ♂♂, 7 ♀♀.

#### PLAGODIS ALCOOLARIA (Guenée)

Plate V, Fig. 15; Plate III, Fig. 1 (male genitalia); Plate IV, Fig. 3 (female genitalia).

*Eurymene alcoolaria* Guenée, Lep. Noct., IX, 146. 1857.

*Eurymene alcoolaria* Gn., Walker, Cat. of the Brit. Museum, XX, 178. 1860.

*Plagodis alcoolaria* (Gn.) Packard, Mon. of Geom. Moths, 469; Plate XI, Fig. 41. 1876.

*Plagodis emargataria* Holland (nec Guenée), Moth Book, 349; Plate XLIV, Fig. 32, ♀. 1903.

*Eurymene alcoolaria* Gn., Oberthür, Etudes de Léop. Comp. Fasc. VI; Plate CLVIII, Fig. 1531. 1920.

The ground color is pale yellow, almost white, but with the upper wings considerably flecked with rusty brown scales, especially in the median area, which, as a result, appears darker than the basal and terminal areas. The postmedial line of the upper wings is dark brown, broad, continuous, and nearly straight or slightly wavy, never strongly curved inward or outward. The antemedial line is also dark brown and complete, and may be nearly straight or somewhat excurved. The discal spot of the upper wings is always conspicuous, and may be either uniform dark brown or with a paler center. The fringes of the upper wings are dark brown, especially along the anal excavation. The lower wings are nearly white, with no markings except a trace of the postmedial line at the inner margin, and a few scattered brown scales near the anal angle. On the under side the pattern of the upper side is repeated, but the dark markings tend to be purple brown, on a background of brighter yellow. The depth of the anal excavation of the upper wings is somewhat variable, but is regularly deeper in the females than in the males.

**MALE GENITALIA.**—The valves are similar in form to those of *phlogosaria*, and the furca is more or less symmetrical, with long-spined tips that extend just beyond the costal edges of the valves. There are, as a rule, two cornuti, sometimes only one, and they are much longer than in any other species of the genus.

**FEMALE GENITALIA.**—The ductus bursæ is long and slender, and fairly well chitinized, as in *serinaria*, but only slightly fluted, not distinctly plaited. There is no bar above the ostium.

**EARLY STAGES.**—The eggs are deposited in a formation that resembles a string of miniature beads extending out from the edge of a leaf. Sometimes these egg masses are forked, and there may be as many as twenty eggs in a mass.

The larvæ in all stages are quite similar to those of *phlogosaria*, but are less mottled and lack the lateral markings of the first two abdominal segments. They have the same habit of withdrawing the head into the thoracic segments when at rest. Mr. Wyatt reports having reared the larvæ successfully on *Tilia*, but I had previously assumed the natural food to be oaks

of various species. A few years ago I reared the larvæ, starting them on white oak, but when they were about half grown I transferred them to beech, since oak was difficult to obtain in the locality. They accepted the change, but afterward grew more slowly, and the mortality rate was high. In western New York the moths do not seem to occur in areas where oak trees are absent, even though beech and basswood are abundant.

The pupa is glossy, with greenish wing cases, similar to that of *phlogosaria*.

*Alcoolaria* is the eccentric species of the genus, appearing in the matters of wing form and early stages to be closely related to *phlogosaria*, while the female genitalia show a marked similarity to those of *serinaria*. In the matters of color, form of the discal spot, and structure of the ædoeagus, it is quite different from any other species. It is difficult to fit it into a linear arrangement of the species, and, for want of a better location I am placing it last in the genus. *Alcoolaria* has an extensive range in eastern United States and Canada, from Nova Scotia to North Carolina, and westward at least to Manitoba. In New York the moths fly in May and June.

Number of specimens examined: 153 ♂♂, 43 ♀♀.

#### PLAGODIS ALCOOLARIA summer form KEMPPII Hulst

Plate V, Fig. 16; Plate III, Fig. 2 (male genitalia).

*Plagodis kempii* Hulst, Jour. N. Y. Ent. Soc., VIII, 220. 1901.

From Pennsylvania southward a summer form occurs in August, which is slightly smaller than typical *alcoolaria*, and brighter yellow, less densely sprinkled with darker scales, and with the other markings sharper and darker. The furca of the male genitalia has longer branches than in typical *alcoolaria*, but in the single specimen examined it is only slightly asymmetrical.

The types of *kempii* are from western Pennsylvania, but I have seen the form from Lakehurst, N. J., and from the mountains of North Carolina. These latter specimens are larger and brighter yellow than the Pennsylvania and New Jersey specimens.

Number of specimens examined: 3 ♂♂, 2 ♀♀.



A discussion of the genus *Plagodis* would hardly be complete without some mention of the very closely related genus *Anagoga* Hübner, which differs so slightly from *Plagodis* that at first I doubted the advisability of retaining both genera. The genus *Anagoga* was erected at the same time as *Plagodis* (Verz. p. 294, 1823), and the European species *pulveraria* Linnæus is recognized as its type. There seem to be no constant differences between the genera in wing venation, antennæ, or other external structures, but differences in the early stages and in the genitalia, while not too great, are probably sufficient to justify the retention of *Anagoga* as a valid genus.

For purposes of comparison, the American species *occiduaria* Wlk. is figured (Plate V, Fig. 17; Plate II, Fig. 4; Plate IV, Fig. 6). *Occiduaria* has usually been considered a race of the European *pulveraria*, but the genitalia are very distinctly different, and according to Bruce (Ent. Amer., II, 51. 1886), so are the larvæ. I have never reared *occiduaria*, but I have a report of the larva from Mr. Franclemont, who has reared it. The mature larva has a slightly bifid, non-retractile head, and the body is thicker at the rear, tapering toward the head. There are humps and warts on the fifth and eighth abdominal segments, somewhat as in *Plagodis*, but smaller. These larvæ, unlike those of *Plagodis*, have the habit of spinning much silk wherever they go, and, in captivity, frequently become hopelessly entangled in their own webs. Mr. Franclemont reared the larvæ on yellow birch (*Betula lutea*).

In the male genitalia *Anagoga* differs somewhat from *Plagodis* in the structure of furca and valves, as shown in the figures. These differences are even more marked in *pulveraria* than in *occiduaria*. There are, furthermore, no cornuti in the ædoeagus. In the female genitalia the signum is a chitinized depression without a pointed edge, quite unlike anything observed in *Plagodis*.

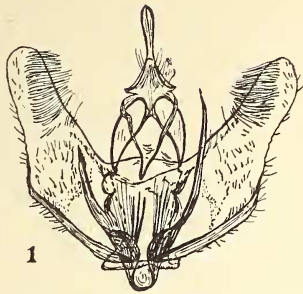
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In conclusion, it gives me pleasure to acknowledge the assistance given by a number of entomologists who have helped in some way to make this article possible. Among them are Mr. John G. Franclemont of the United States National Museum,

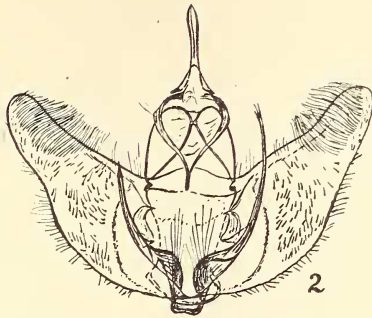
Dr. W. T. M. Forbes of Cornell University, Mr. Douglas C. Ferguson of Armdale, N. S., Dr. Frank M. Jones of Wilmington, Del., Mr. A. K. Wyatt of Chicago, Ill., and Mr. Otto Buchholz of Roselle Park, N. J. I am also indebted to the officials of the Museum of Comparative Zoology for the privilege of examining the material in that collection, and to Dr. Walter R. Sweadner, whose loan to Mr. Franclemont of the material in the Carnegie Museum was of great value in determining the true status of *purpuraria* and *schuylkillensis*.

## PLATE I

- Figure 1. *Plagodis dolabraria* L., male genitalia; 1a, ædæagus.  
Figure 2. *Plagodis serinaria* H.S., male genitalia; 2a, ædæagus.  
Figure 3. *Plagodis kuetzingi* Grt., male genitalia; 3a, ædæagus.  
Figure 4. *Plagodis purpuraria* Pears., male genitalia; 4a, ædæagus.  
Figure 5. *Plagodis phlogosaria* Gn., male genitalia; 5a, ædæagus.  
Figure 6. *Plagodis phlogosaria* spring form *kuetzingaria* Pack., male genitalia; 6a, ædæagus.



1



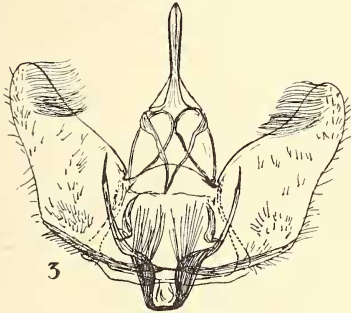
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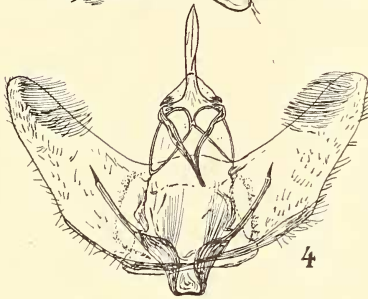
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2a



3



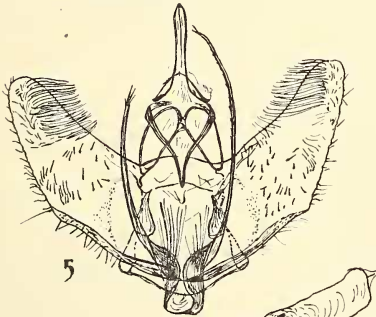
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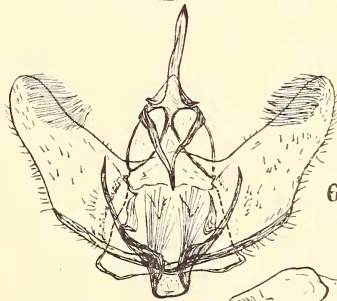
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4a



5



6

5a



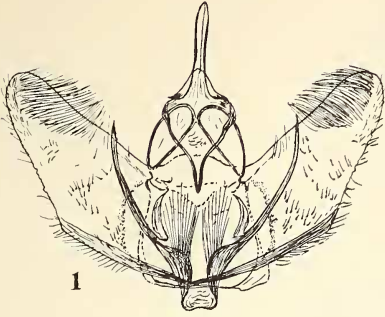
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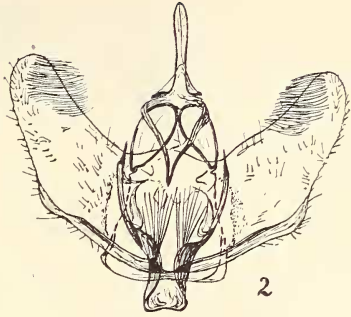
## PLATE II

- Figure 1. *Plagodis phlogosaria* race *approximaria* Dyar, male genitalia (summer form); 1a, ædœagus.
- Figure 2. *Plagodis fervidaria* H.-S., male genitalia; 2a, ædœagus.
- Figure 3. *Plagodis fervidaria* summer form *arrogaria* Hlst., male genitalia; 3a, ædœagus.
- Figure 4. *Anagoga occiduaria* Wlk., male genitalia; 4a, ædœagus.
- Figure 5. *Plagodis serinaria* H.-S., larva.





1



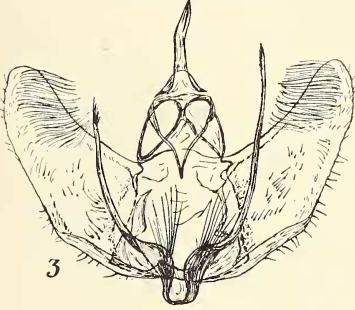
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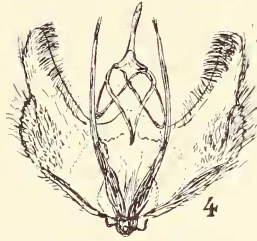
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2a



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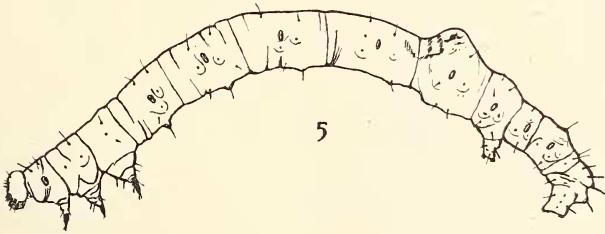
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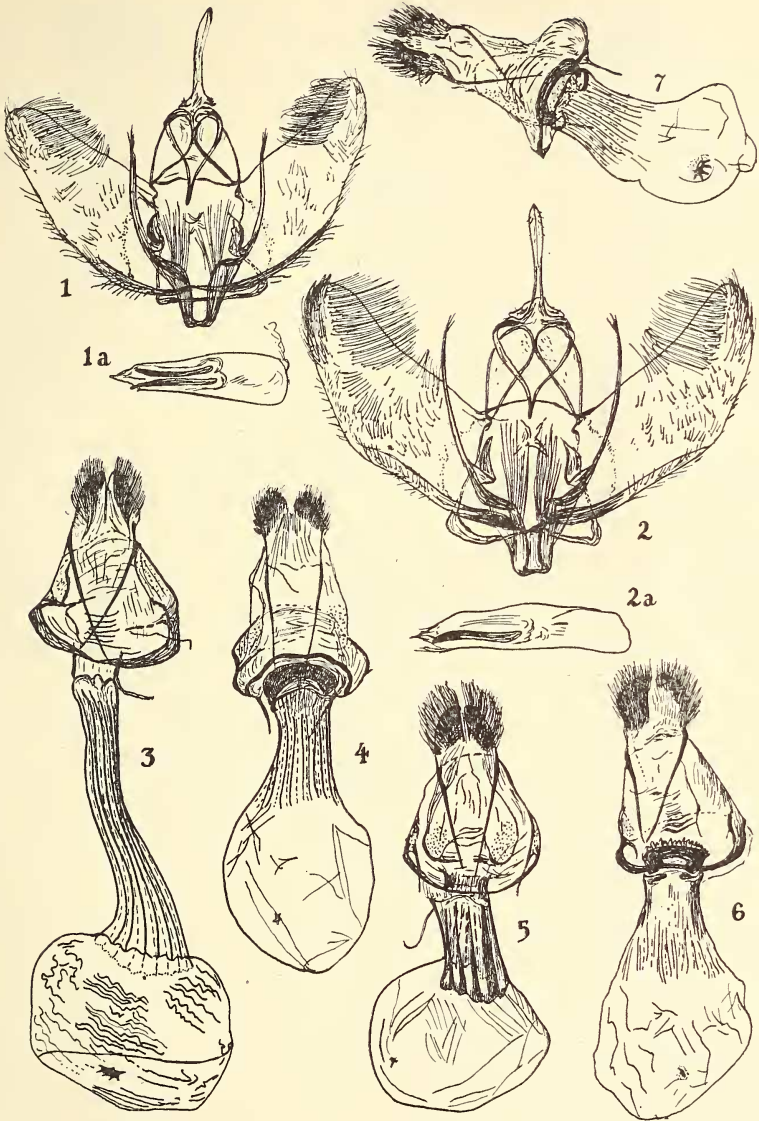
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5

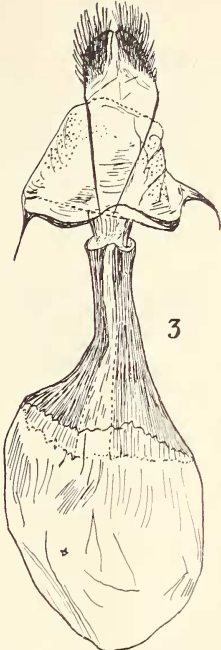
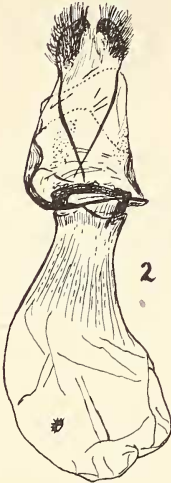
## PLATE III

- Figure 1. *Plagodis alcoolaria* Gn., male genitalia; 1a, ædæagus.  
Figure 2. *Plagodis alcoolaria* summer form *kempii* Hlst., male genitalia;  
2a, ædæagus.  
Figure 3. *Plagodis serinaria* H.-S., female genitalia.  
Figure 4. *Plagodis kuetzingi* Grt., female genitalia.  
Figure 5. *Plagodis dolabraria* L., female genitalia.  
Figure 6. *Plagodis purpuraria* Pears., female genitalia.  
Figure 7. *Plagodis fervidaria* summer form *arrogaria* Hlst., female genitalia.



## PLATE IV

- Figure 1. *Plagodis phlogosaria* Gn., female genitalia.  
Figure 2. *Plagodis phlogosaria* spring form *keutzingaria* Paek., female genitalia.  
Figure 3. *Plagodis alcoolaria* Gn., female genitalia.  
Figure 4. *Plagodis phlogosaria* race *approximaria* Dyar, female genitalia.  
Figure 5. *Plagodis fervidaria* H.-S., female genitalia.  
Figure 6. *Anagoga occiduaria* Wlk., female genitalia.





## PLATE V

- Figure 1. *Plagodis dolabraria* L., ♂ (Kaufung, Germany). Forbes coll.
- Figure 2. *Plagodis serinaria* H.-S., ♂ (McLean Bogs, Tompkins Co., N. Y.). Franclemont coll.
- Figure 3. *Plagodis kuetzingi* Grt., ♂ (Six Mile Creek, Ithaca, N. Y.). Franclemont coll.
- Figure 4. *Plagodis purpuraria* Pears., ♂ (Oak Station, Allegheny Co., Penna.). Carnegie Museum coll.
- Figure 5. *Plagodis purpuraria* summer form *schuylkillensis* Grossb., ♂ (Finleyville, Washington Co., Penna.). Carnegie Museum coll.
- Figure 6. *Plagodis phlogosaria* Gn., ♂ (Sardinia, N. Y.).
- Figure 7. *Plagodis phlogosaria* spring form *keutzingaria* Pack., ♂ (Horseheads, N. Y.).
- Figure 8. *Plagodis phlogosaria* race *intermediaria* B. and McD., ♀ (Bobbygeon, Ont., bred by McDunnough). Franclemont coll.
- Figure 9. *Plagodis phlogosaria* race *iris* new race, ♂ (Armdale, N. S.).
- Figure 10. *Plagodis phlogosaria* race *approximaria* Dyar, ♂ spring form (Pullman, Wash.). Cornell University coll.
- Figure 11. *Plagodis phlogosaria* race *approximaria* Dyar, ♂ summer form (Warrendale, Multnomah Co., Ore.). Franclemont coll.
- Figure 12. *Plagodis fervidaria* H.-S., ♂ (Camp Rueker, Ozark, Ala.). Franclemont coll.
- Figure 13. *Plagodis fervidaria* summer form *arrogaria* Hlst., ♂ (Monteagle, Tenn.). Cornell University coll.
- Figure 14. *Plagodis fervidaria* summer form *arrogaria* Hlst., ♀ (Oak Station, Penna.). Carnegie Museum coll.
- Figure 15. *Plagodis alcoolaria* Gn., ♂ (Horseheads, N. Y.).
- Figure 16. *Plagodis alcoolaria* summer form *kempii* Hlst., ♂ (Brevard, N. C.). Cornell University coll.
- Figure 17. *Anagoga occiduaria* Wlk., ♂ (Six Mile Creek, Ithaca, N. Y.). Franclemont coll.

